Defence Research and Development Canada
Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

Cognitive effectiveness of CF18 instructor pilots during routine training

Michel A. Paul
Gary W. Gray
DRDC Toronto

James C. Miller
USAF AFRL Brooks City Base, TX

Defence R&D Canada
Technical Report
DRDC Toronto TR 2007-028
February 2007

Canada

Cognitive effectiveness of CF18 instructor pilots during routine training

Michel A. Paul
Gary W. Gray
DRDC Toronto

James C. Miller
USAF AFRL Brooks City Base, TX

Defence R&D Canada – Toronto

Technical Report
DRDC Toronto TR 2007-028
February 2007

Principal Author

Original approved by

Michel Paul

Approved by

Original approved by

Pang Shek

Section Head IRS

Approved for release by

Original approved by

K.M. Sutton

Chair, Document Review and Library Committee

In conducting the research described in this report, the investigators adhered to the policies and procedures set out in the Tri-Council Policy Statement: Ethical conduct for research involving humans, National Council on Ethics in Human Research, Ottawa, 1998 as issued jointly by the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada.

Abstract

Introduction. 410 Squadron (the operational training squadron -OTS- for CF18 pilots) was tasked to evaluate the efficacy of night vision goggles (NVGs). Since evaluation of NVGs involves night flying operations along with the inevitable circadian stresses induced by night operations, and since exercise Wolf Safari (an around-the-clock air-to-ground bombing exercise) occurred at 4 Wing (the same base as 410 OTS) there was an opportunity to capitalize on exercise Wolf Safari by running a parallel evaluation on instructor pilots of 410 OTS during their evaluation of NVGs. **Methods:** Cognitive effectiveness was predicted using the Fatigue Avoidance and Scheduling Tool (**FAST™**). Based on sleep and wakefulness data, the program predicts cognitive effectiveness**. Results. The FAST™** analysis predicted moderate cognitive impairment in all three instructor pilots during stand-by duty and during flight. **Discussion.** The lowest predicted cognitive effectiveness levels (during duty periods of these pilots) was due to inadequate sleep the night prior the duty periods in question. The anticipated tasking for 410 OTS to assess NVGs did not take place. However, should such an NVG tasking materialize in the future, the FAST™ tool would predict that the night flying inherent in such an evaluation could cause more deleterious effects on cognitive effectiveness. This report can serve as baseline against which the anticipated more severe effects on cognitive effectiveness (of a future NVG assessment) can be compared.

Résumé

Introduction. Le 410e Escadron (escadron d’entraînement opérationnel [EEO] pour les pilotes de CF18) a été chargé d’évaluer l’efficacité des lunettes de vision nocturne (LVN). Comme l’évaluation des LVN nécessite des vols de nuit accompagnés des inévitables variations du rythme circadien induites par les vols de nuit, et comme l’exercice World Safari (exercice de bombardement air-sol ininterrompu) avait lieu à la 4e Escadre (où est basé le 410 EEO), il y avait une occasion de profiter de l’exercice World Safari en tenant une évaluation parallèle sur les pilotes instructeurs du 410 EEO lors de leur évaluation des LVN. **Méthodes :** L’efficacité cognitive a été prédite au moyen de l’outil de programmation et d’évitement de la fatigue (**FAST™**). Sur la foi des données de sommeil et de vigilance, le programme prédit l’efficacité cognitive. **Résultats.** L’analyse **FAST™** a prédit une déficience cognitive moyenne chez les trois pilotes instructeurs pendant la période de disponibilité et le vol. **Exposé.** Les niveaux d’efficacité cognitive les plus faibles prévus (pendant la période de service de ces pilotes) avaient été causée par un sommeil insuffisant la nuit précédant les périodes de service en question. La mission prévue pour le 410 EEO d’évaluer les LVN n’a pas eu lieu. Par contre, si cette mission sur les LVN devait être reprise ultérieurement, l’outil FAST™ prédirait que le vol de nuit propre à cette évaluation pourrait avoir des effets nuisibles sur l’efficacité cognitive. Le présent rapport peut servir de référence pour comparer les effets plus graves anticipés sur l’efficacité cognitive (d’une évaluation ultérieure de LVN).

This page intentionally left blank.

Executive summary

Cognitive Effectiveness of CF18 Instructor Pilots during Routine Training:

Michel A. Paul; Gary W. Gray; James C. Miller; DRDC Toronto TR 2007-028; Defence R&D Canada – Toronto

Background: 4 Wing recently hosted an 'around the clock' air-to-ground exercise (Wolf Safari) prior to possible deployment of CF-18 aircraft to support our troops in Afghanistan. Based on recommendations from 1 CAD surgeon, DRDC Toronto received a tasking from 4 Wing to develop models of cognitive effectiveness of CF18 pilots during Exercise Wolf Safari. Cognitive effectiveness is determined by inputting daily sleep data and daily duty data into a recently developed modelling program, the **Fatigue Avoidance Scheduling Tool (FAST™).** The CF18 Operational Training Squadron (OTS) also based at 4 Wing was tasked to evaluate Night Vision Goggles (NVGs). The DRDC Toronto evaluation of Wolf Safari created a parallel opportunity to support evaluation of NVGs by the OTS.

Results: The NVG evaluation did not occur during the monitored period. However, the **FAST™** modelling tool predicted that all 3 OTS instructor pilots showed moderate impacts of cognitive effectiveness in response to routine training.

Significance: It is evident that the lowest cognitive effectiveness levels (during duty periods of these pilots) is due to inadequate sleep the night prior to the duty periods in question. While the anticipated tasking for 410 OTS to assess NVGs did not take place, the current report which is based on routine training will serve as a baseline against which to compare the more deleterious impacts on cognitive effectiveness inherent in night operations such that an NVG trial might materialize in the future. In the interim, our fighter pilots should be reminded to make every effort to obtain sufficient sleep during the night prior to any flying activities.

Sommaire

Efficacité cognitive de pilotes instructeurs de CF18 pendant l'entraînement de routine :

Michel A. Paul; Gary W. Gray; James C. Miller, DRDC Toronto TR 2007-028, R & D pour la défense Canada – Toronto

Introduction : La 4e Escadre a récemment tenu un exercice de bombardement air-sol « ininterrompu » (World Safari) avant le déploiement éventuel d'avions CF-18 pour appuyer nos troupes en Afghanistan. Sur la foi des recommandations du médecin de la 1 DAC, RDDC Toronto s'est vu confier par la 4e Escadre le développement de modèles d'efficacité cognitive des pilotes de CF-18 au cours de l'exercice World Safari. L'efficacité cognitive est déterminée par l'entrée de données quotidiennes sur le sommeil dans un programme de modélisation récemment élaboré, l'**outil de programmation et d'évitement de la fatigue (FAST^{TM}).** L'escadron d'entraînement opérationnel (EEO) de CF-18 aussi basé à la 4e Escadre a été chargé d'évaluer les lunettes de vision nocturne. L'évaluation de World Safari par RDDC Toronto a aussi donné l'occasion de faire effectuer l'évaluation des LVN par l'EEO.

Résultats : L'évaluation des LVN n'a pas eu lieu au cours de la période prévue. Par contre, l'outil de modélisation **FAST^{TM}** a prédit que les trois (3) pilotes instructeurs de l'EEO présentaient des déficiences moyennes d'efficacité cognitive résultant de l'entraînement de routine.

Portée : Il est évident que les plus faibles niveaux d'efficacité cognitive (pendant les périodes de service) sont attribuables à un sommeil insuffisant la nuit précédant les périodes de service en question. Même si la mission prévue pour le 410 EEO d'évaluer les LVN n'a pas eu lieu, le rapport actuel, fondé sur l'entraînement de routine, va servir de référence pour comparer les effets plus nuisibles sur l'efficacité cognitive qui sont propres aux vols de nuit le temps qu'un essai des LVN ait lieu plus tard. Dans l'intervalle, nos pilotes de chasse doivent s'efforcer d'obtenir suffisamment de sommeil la nuit précédant toute activité de vol.

Table of contents

List of Tables and Figures

1 Background

In response to requests from 1 Canadian Air Division (1 CAD) Surgeon, DRDC Toronto has recently drafted reports on air transport aircrew fatigue assessments (1), assessment of sleeping medication use in air transport aircrew (2), and cognitive assessment of CF18 pilots during an ‘around-the-clock’ air-to-ground exercise (Wolf Safari) (3). During exercise Wolf Safari, 410 Squadron, the operational training squadron (OTS) for CF18 pilots, was tasked to evaluate the efficacy of night vision goggles (NVGs). Since evaluation of NVGs involves night flying operations along with the inevitable circadian stresses induced by night operations, and since Wolf Safari occurred at 4 Wing (the same base as 410 OTS) this was an opportunity to capitalize on Wolf Safari by running a parallel evaluation on instructor pilots of 410 OTS.

2 FAST™ Analysis of CF18 Instructor Pilots During Routine Training

2.1 FAST™ Modelling Program

A description of the FAST™ (Fatigue Avoidance Scheduling Tool) is provided in Appendix C. Fast™ graphs are shown in Appendices A and B. The graphs in Appendix A illustrate predicted cognitive effectiveness during the entire daily work days, whereas the graphs in Appendix B illustrate cognitive effectiveness only during actual flight. Some details of these graphs are as follows:

- The vertical axis on the left side of the FAST™ graphs represents human performance effectiveness and is demonstrated by the oscillating line in the diagram representing group average performance (cognitive effectiveness) as determined by time of day, biological rhythms, time spent awake, and amount of sleep.

- The dotted line which is below the cognitive effectiveness curve and follows a similar oscillating pattern as the cognitive effectiveness represents the 10th percentile of cognitive effectiveness.

- The green band represents acceptable performance effectiveness for workers conducting safety sensitive work (flying, driving, weapons operation, command and control, etc.).

- The yellow performance band (from 65% to 90% cognitive effectiveness) indicates caution. Personnel engaged in skilled performance activities such as aviation should not be functioning in this band.

- The area from the dotted line to the pink area represents cognitive effectiveness during the circadian nadir and equivalent to a 2nd day without sleep.

- The pink performance band (below 65%) represents performance effectiveness after 2 days and a night of sleep deprivation. Under these conditions, no one can be expected to function well on any task.

- The vertical axis on the right side of FAST™ graphs represents the blood alcohol equivalence throughout the spectrum of cognitive effectiveness. A value of 77% cognitive effectiveness corresponds to a blood alcohol of 0.05%.

- The abscissa illustrates periods of work (red bars), sleep (blue bars), darkness (gray bars) and time of day in hours.

2.2 Modelling methods

Two methods were used to determine the predicted levels of cognitive effectiveness during duty periods. In both methods, the daily sleep minutes as measured by the wrist activity monitor (WAM) were inputted into the FAST^{TM} program, where normal nocturnal home sleep was classified as excellent, sleep on the base during duty periods was classified as good, and on-base day sleep was classified as moderate.

In method one, the entire work period, including flying time is recorded as a work period (graphs in Appendix A). In method two, to illustrate cognitive effectiveness during flight, only the actual flying time is recorded as a work period (graphs in Appendix B). For both methods, the cognitive effectiveness during the work period is shown as the expected red bar on the abscissa and as a thickening of the cognitive effectiveness line immediately above the red bars on the abscissa.

2.3 Modelling results

The daily duty period cognitive effectiveness (method 1) of each of 3 pilots who participated in this operational assessment is illustrated in a 14-day model of cognitive effectiveness (Appendix A). However, the cognitive effectiveness during actual flight (method 2) is only illustrated in 2 of the 3 pilots since pilot 1 did not provide take-off (T/O) and landing times.

The average pilot cognitive effectiveness for each of methods 1(during entire duty period) and 2 (during actual flight) are shown in table 1.

Table 1: Average pilot cognitive effectiveness during entire duty period and during actual flight

Pilot identification #	**Duty period Cognitive effectiveness (%)**	**Cognitive effectiveness during actual flight (%)**
Pilot #1	90	T/O & Landing times missing
Pilot #2	93	93
Pilot #3	91	91

During the duty and flying periods, there were cognitive effectiveness levels significantly above as well as significantly below the averages reported in table 1.

3 Discussion

All of the cognitive effectiveness models in appendices A and B were 14-day models.

The modelled cognitive effectiveness of pilot 1 averaged 90% across all his duty periods, and his corresponding range of cognitive effectiveness ran from a high of 95% to a low of 79% (Appendix A, A.1). This pilot's lowest duty cognitive effectiveness (indicated by a red triangle event marker shown on the duty period red band of the abscissa and marked as "C1"), occurred on November 21st, as was clearly secondary to a minimum 4 hour and 4 minute sleep (from 2239 hrs to 0230 hrs) during the night of November 20th/November 21st. Since we do not have the T/O and landing times for the flights undertaken by this pilot we are unable to generate a model (method 2) to illustrate his cognitive effectiveness during actual flight.

The average modelled cognitive effectiveness of pilot 2 was 93% during his daily duty periods as well as during his actual flights. During his daily duty periods his range of cognitive effectiveness was from 99% to 87% (Appendix A, A.2) and the corresponding range during actual flight (Appendix B, B.2) was 97% to 88%. Note that during his November 9th flight this pilot's relatively low cognitive effectiveness is also secondary to a limited 5 hr and 48 minute sleep (asleep at 2349 hrs and up at 0537 hrs) period the night prior to this flight.

The FAST™ model for pilot 3 indicated an average cognitive effectiveness of 91% across his daily exercise Wolf Safari duty periods (Appendix A, A.3) ranging from 98% to 84%. His average cognitive effectiveness during flight also averaged 91% and ranged from 97% to 84%. This pilot's lowest cognitive effectiveness during flight (84%) occurred on November 6th and similar to pilot 2, this low level of cognitive effectiveness is certainly due to inadequate sleep the night prior to this flight (280 minutes total sleep commencing at 0230 hrs and ending at 0710 hrs).

All 3 pilots who participated in this evaluation showed moderate reductions in predicted cognitive effectiveness (i.e. below 90%). It is clearly evident that the lowest cognitive effectiveness levels (during duty periods of these pilots) is due to inadequate sleep the night prior the duty periods in question. The anticipated tasking for 410 OTS to assess NVGs did not take place. Certainly, should such an NVG tasking materialize in the future, the night flying inherent in such an evaluation will cause more deleterious effects on cognitive effectiveness than we can report here. Nonetheless, this report can serve as baseline against which the anticipated more severe effects on cognitive effectiveness (of a future NVG assessment) can be compared.

4 Conclusions

Even having a single night of inadequate sleep prior to flying can result in impacts on modelled cognitive effectiveness.

5 Recommendations

1) Fighter pilots should be encouraged to obtain more sleep prior to next-day flying activities.

References

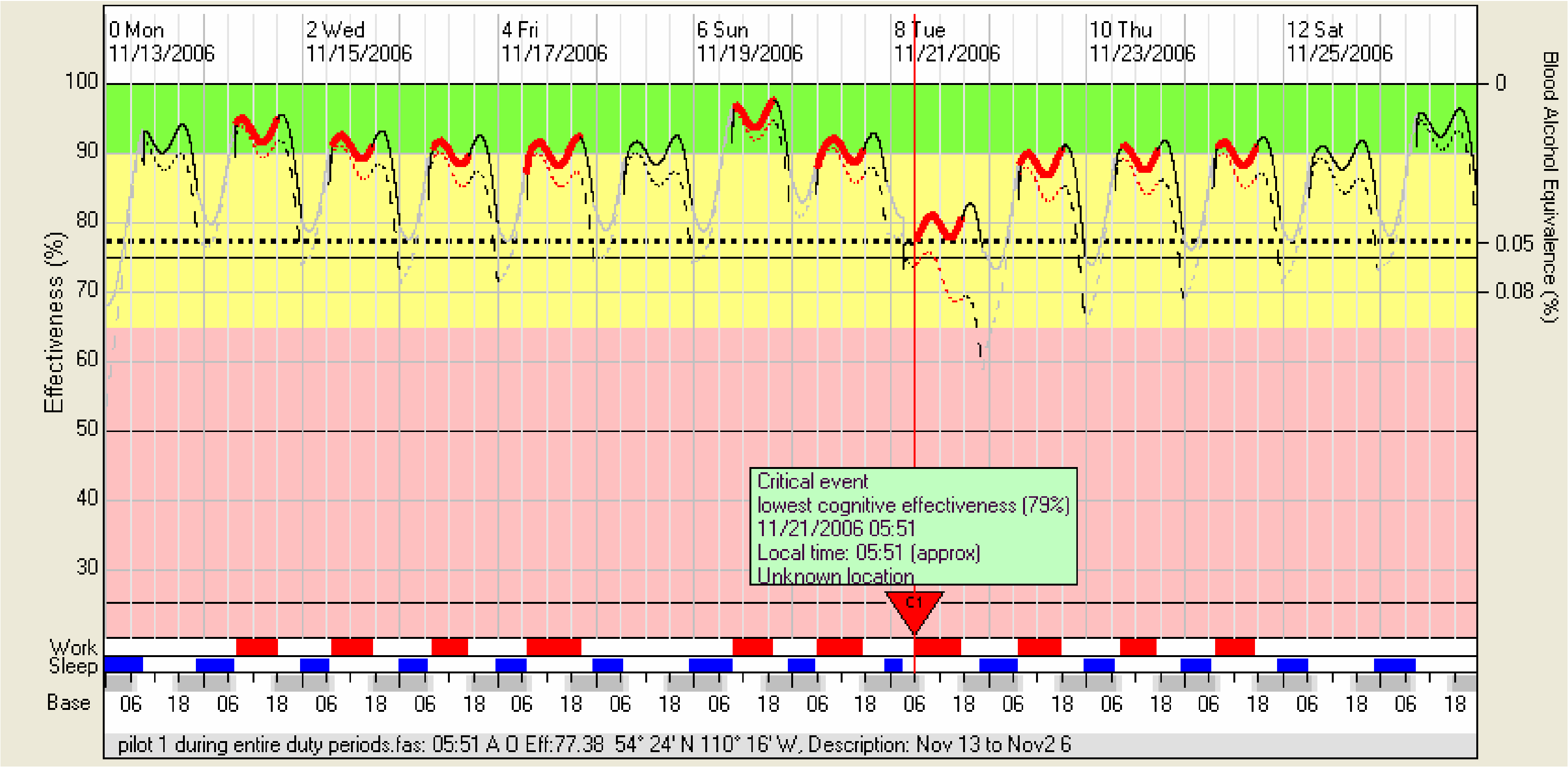
1. Paul MA, Miller JC. Fatigue Assessment in Camp Mirage CC130 Aircrew: recommendations for pharmacologic intervention: DRDC Toronto February 2004. Report No.: TR 2004-021.

2. Paul MA, Gray GW, Miller JC. Preliminary assessment of zopiclone (Imovane™) use in Camp Mirage Aircrew: DRDC Toronto May 2006. Report No.: TR 2006-077.

3. Paul MA, Gray GW, Miller JC. Fighter Pilot Cognitive Effectiveness During Exercise Wolf Safari: DRDC Toronto February 2007. Report No.: TR 2007-020.

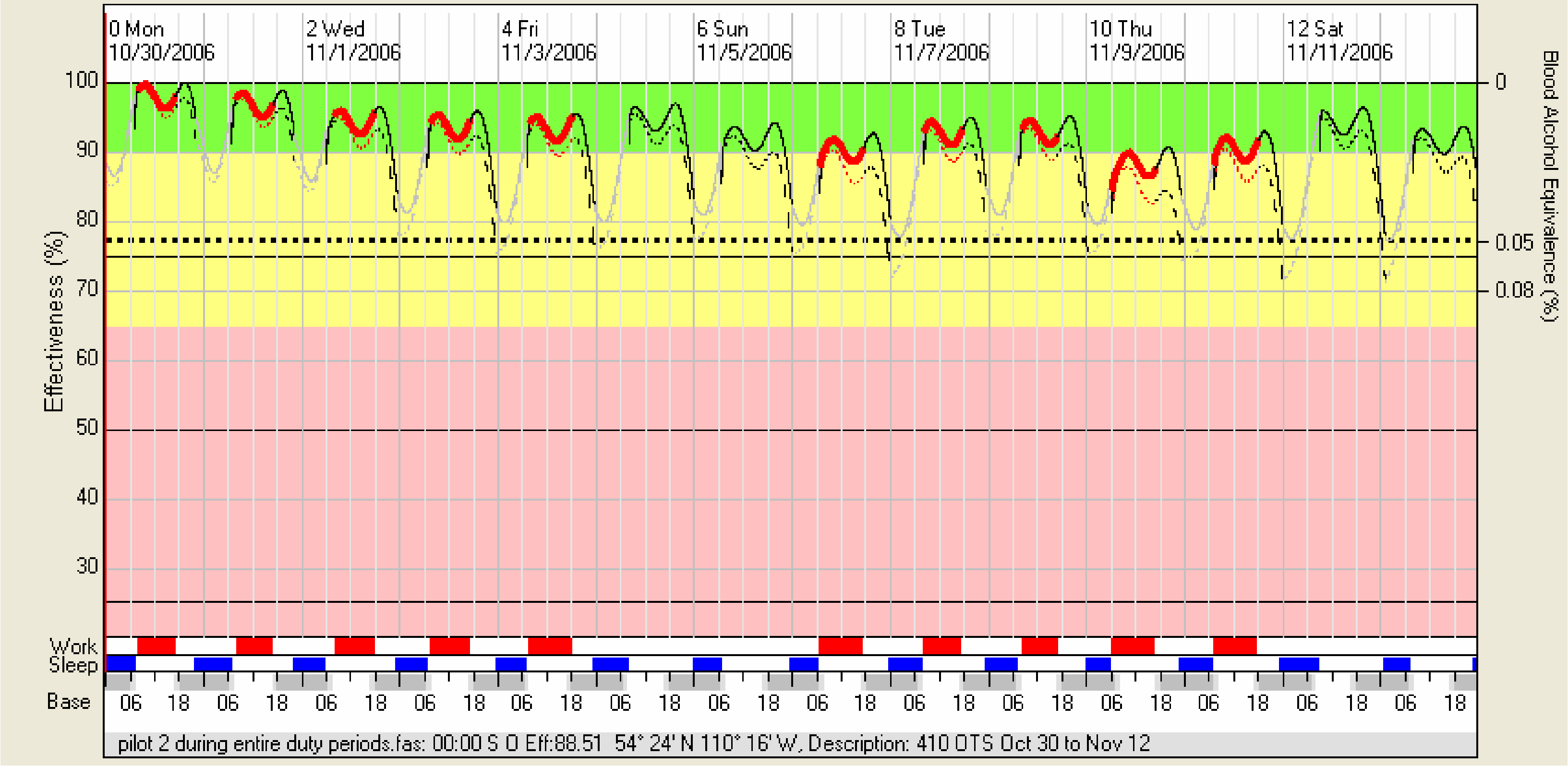
ANNEX A FAST™ Graphs for individual pilots (Method 1)

Pilot 1



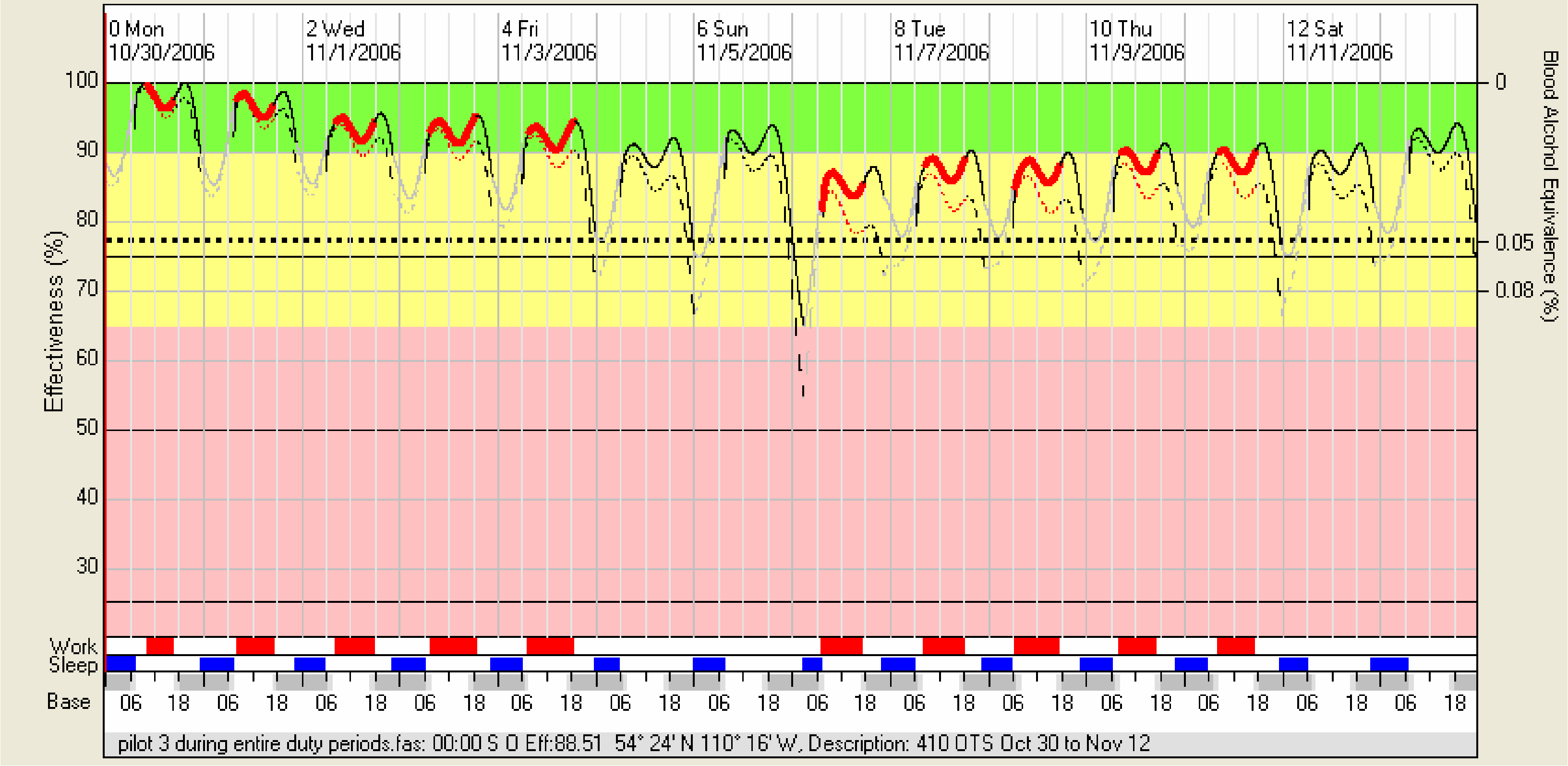
Average cognitive effectiveness during entire duty periods is 90 %

Pilot 2



Average cognitive effectiveness during entire duty periods is 93 %

Pilot 3

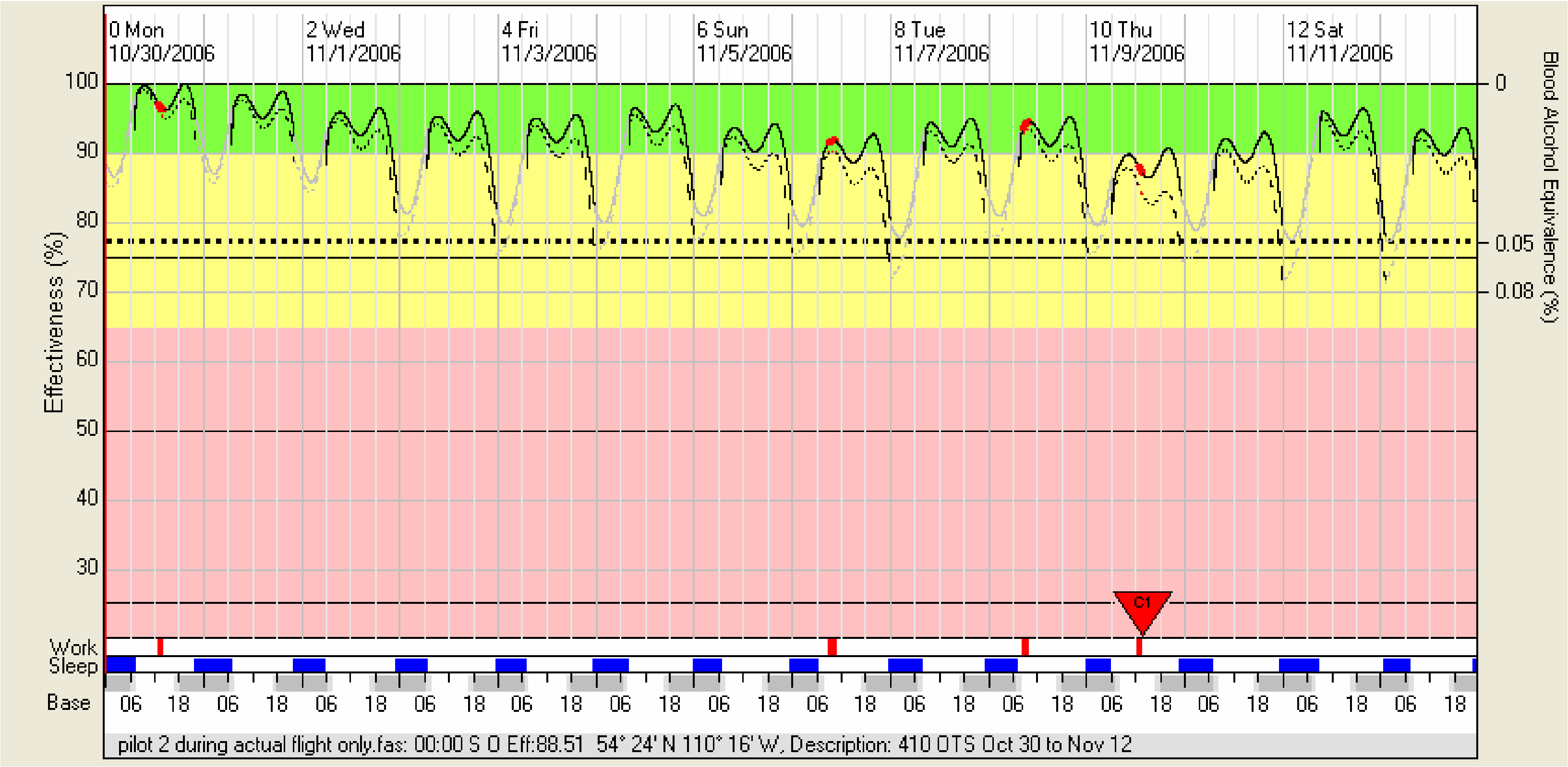


Average cognitive effectiveness during entire duty periods is 91 %

This page intentionally left blank.

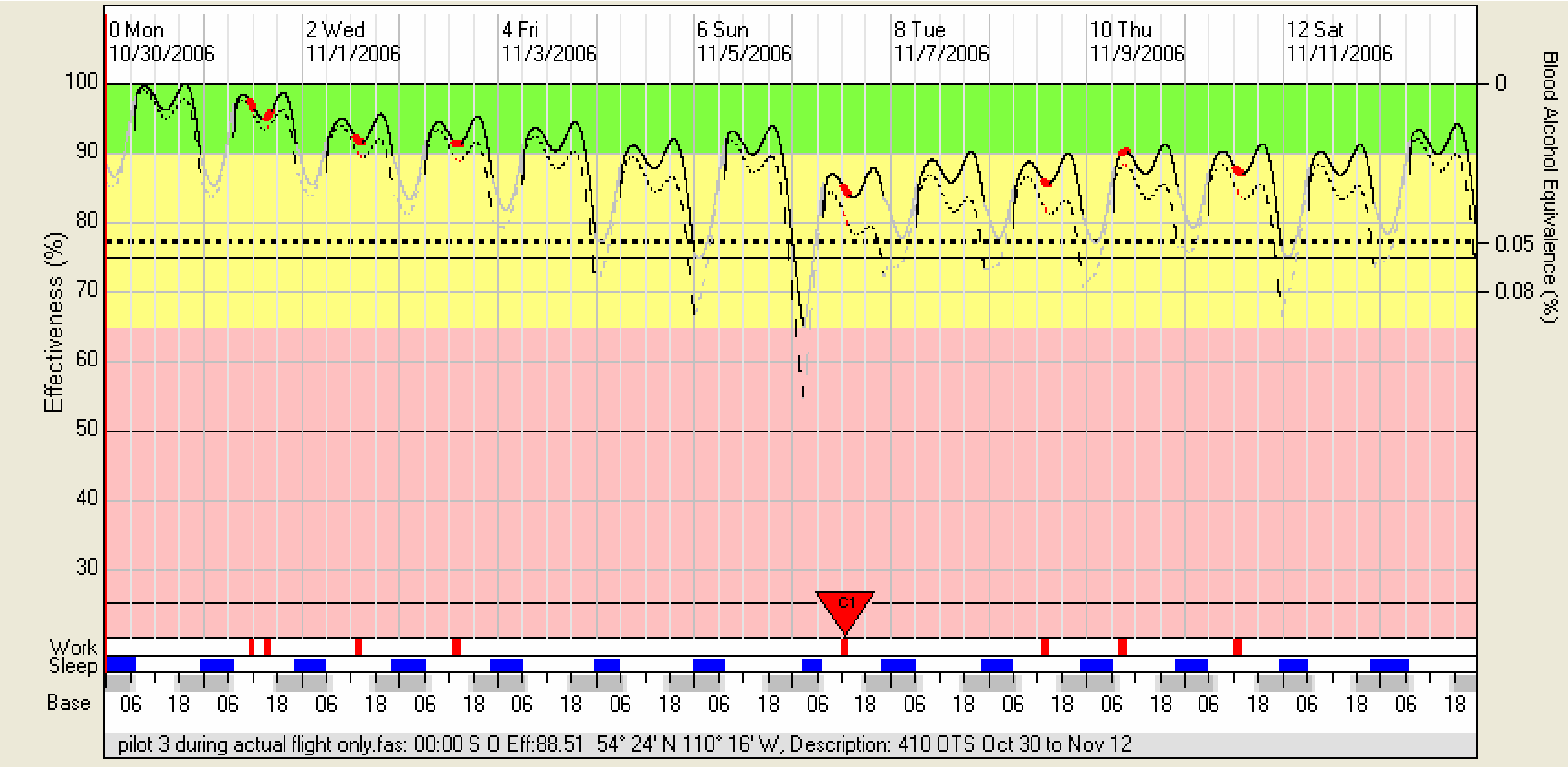
ANNEX B FAST™ Graphs for individual pilots (Method 2)

Pilot 2



Average cognitive effectiveness during flight periods is 93%

Pilot 3



Average cognitive effectiveness during flight periods is 91%

ANNEX C Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) Model

Fatigue Avoidance Scheduling Tool (*FAST*™)

The Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) model integrates quantitative information about (1) circadian rhythms in metabolic rate, (2) cognitive performance recovery rates associated with sleep, and cognitive performance decay rates associated with wakefulness, and (3) cognitive performance effects associated with sleep inertia to produce a 3-process model of human cognitive effectiveness.

The SAFTE model has been under development by Dr. Steven Hursh for more than a decade. Dr. Hursh, formerly a research scientist with the US Army, is employed by SAIC (Science Applications International Corporation) and Johns Hopkins University and is currently under contract to the WFC (Warfighter Fatigue Countermeasures) R&D Group and NTI, Inc. to modify and expand the model.

The general architecture of the SAFTE model is shown in Figure 1. A circadian process influences both cognitive effectiveness and sleep regulation. Sleep regulation is dependent upon hours of sleep, hours of wakefulness, current sleep debt, the circadian process and sleep fragmentation (awakenings during a sleep period). Cognitive effectiveness is dependent upon the current balance of the sleep regulation process, the circadian process, and sleep inertia.

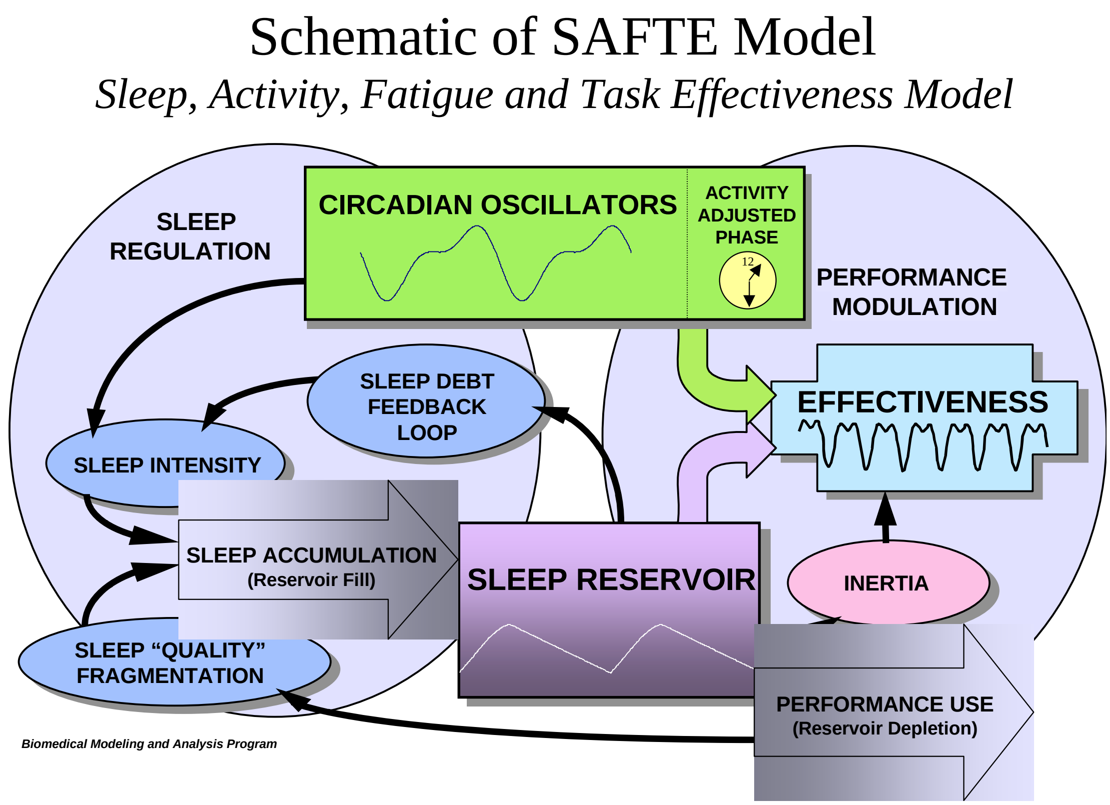


Figure 1. Schematic of SAFTE Model

SAFTE has been validated against group mean data from a Canadian laboratory that were not used in the model's development (Hursh et al., in review). Additional laboratory and field validation studies are underway and the model has begun the USAF Verification, Validation and Accreditation (VV&A) process.

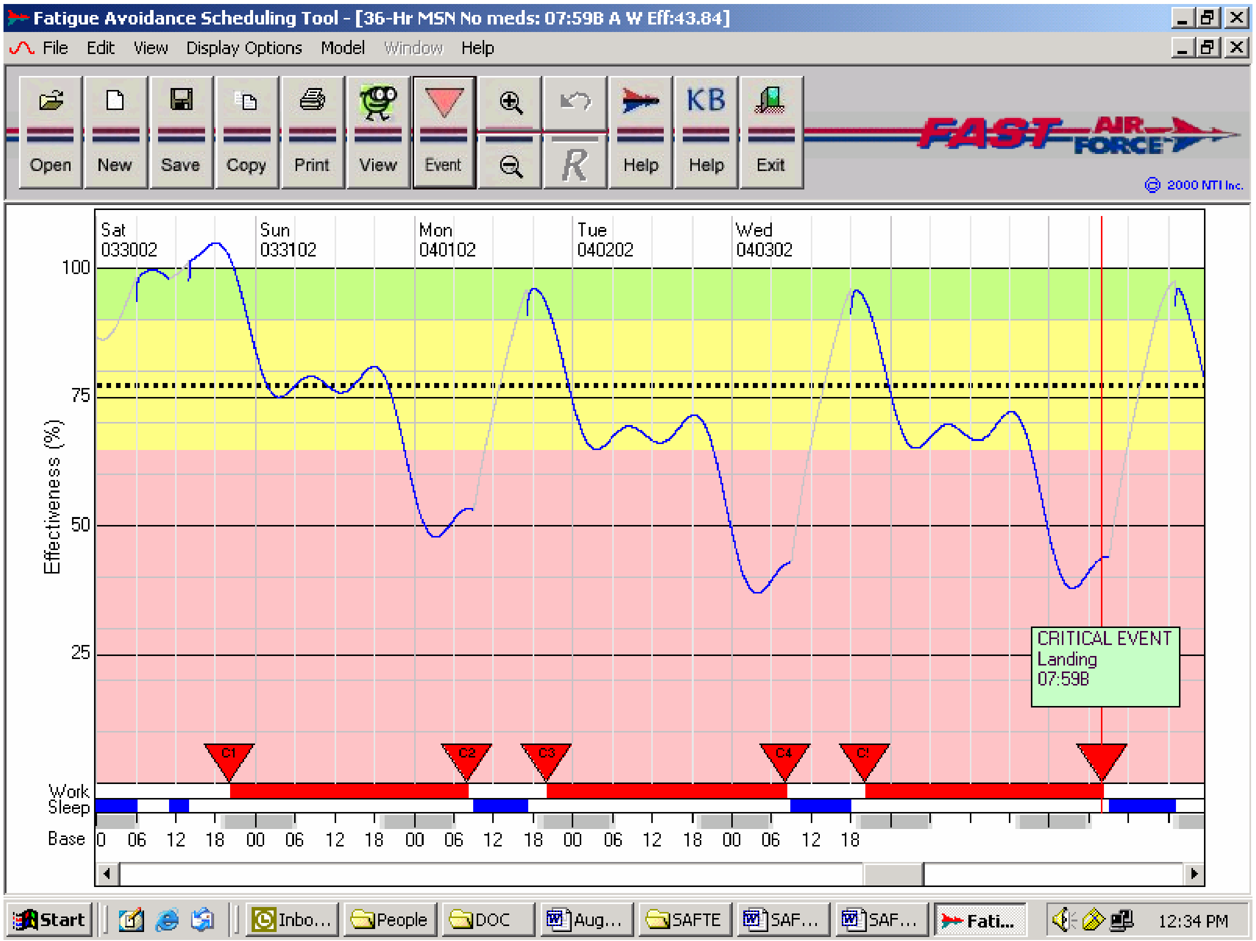
The model does not incorporate the effects of pharmacological alertness aids; chronic fatigue (motivational exhaustion); chronic fatigue syndrome; fatiguing physiological factors such as exercise, hypoxia or acceleration; sleep disorders; or the fatiguing effects of infection.

The SAFTE Model has a number of essential features that distinguish it from other attempts to model sleep and fatigue (Table D-1). Together, these features of the model allow it to make very accurate predictions of performance under a variety of work schedules and levels of sleep deprivation.

Table 1. SAFTE model essential features.

KEY FEATURES	ADVANTAGES
Model is homeostatic. Gradual decreases in sleep debt decrease sleep intensity. Progressive increases in sleep debt produced by extended periods of less than optimal levels of sleep lead to increased sleep intensity.	Predicts the normal decline in sleep intensity during the sleep period. Predicts the normal equilibrium of performance under less than optimal schedules of sleep.
Model delays sleep accumulation at the start of each sleep period.	Predicts the detrimental effects of sleep fragmentation and multiple interruptions in sleep.
Model incorporates a multi-oscillator circadian process.	Predicts the asymmetrical cycle of performance around the clock.
Circadian process and Sleep-Wake Cycle are additive to predict variations in performance.	Predicts the mid-afternoon dip in performance, as well as the more predominant nadir in performance that occurs in the early morning.
Model modulates the intensity of sleep according to the time of day.	Predicts circadian variations in sleep quality. Predicts limits on performance under schedules that arrange daytime sleep.
Model includes a factor to account for the initial lag in performance upon awakening.	Predicts sleep inertia that is proportional to sleep debt.
Model incorporates adjustment to new time zones or shift schedules	Predicts temporary "jet-lag" effects and adjustment to shift work

The Fatigue Avoidance Scheduling Tool (*FAST*™) is based upon the SAFTE model. *FAST*™, developed by NTI, Inc. as an AF SBIR (Air Force, Small Business Innovative Research) product, is a Windows® program that allows planners and schedulers to estimate the average effects of various schedules on human performance. It allows work and sleep data entry in graphic and text formats. A work schedule comprised of three 36-hr missions each separated by 12 hours is shown as red bands on the time line across the bottom of the graphic presentation format in Figure 2. Average performance effectiveness for work periods may be extracted and printed as shown in the table below the figure.



AWAKE			WORK		
Start Day - Hr	Duration (Minutes)	Mean Effectiveness	Start Day - Hr	Duration (Minutes)	Mean Effectiveness
0 - 06:00	300	98.97	0 - 20:00	1079	81.14
0 - 14:00	2580	76.42	1 - 14:00	1080	63.97
2 - 17:00	2400	64.78	2 - 20:00	1079	71.23
4 - 18:00	2340	64.58	3 - 14:00	1080	54.51
6 - 19:00	1741	72.23	4 - 20:00	1079	72.00
			5 - 14:00	1080	54.92

Figure 2: Sample FAST^{tm} display. The triangles represent waypoint changes that control the amount of light available at awakening and during various phases of the circadian rhythm. The table shows the mission split into two work intervals, first half and second half.

Sleep periods are shown as blue bands across the time line, below the red bands.

The vertical axis of the diagram represents composite human performance on a number of associated cognitive tasks. The axis is scaled from zero to 100%. The oscillating line in the diagram represents expected group average performance on these tasks as determined by time of day, biological rhythms, time spent awake, and amount of sleep. We would expect the predicted performance of half of the people in a group to fall below this line.

The green area on the chart ends at the time for normal sleep, ~90% effectiveness.

The yellow indicates caution.

The area from the dotted line to the red area represents performance level during the nadir and during a 2nd day without sleep.

The red area represents performance effectiveness after 2 days and a night of sleep deprivation.

The expected level of performance effectiveness is based upon the detailed analysis of data from participants engaged in the performance of cognitive tasks during several sleep deprivation studies conducted by the Army, Air Force and Canadian researchers. The algorithm that creates the predictions has been under development for two decades and represents the most advanced information available at this time.

References

[1] Eddy DR, Hursh SR (2001). *Fatigue Avoidance Scheduling Tool (FAST).* AFRL-HE-BR-TR-2001-0140, SBIR Phase I Final Report, Human Effectiveness Directorate Biodynamics and Protection Division, Flight Motion Effects Branch, Brooks AFB TX 78235-5105.

[2] Hursh SR, Redmond DP, Johnson ML, Thorne DR, Belenky G, Balkin TJ, Storm WF, Miller JC, Eddy DR. (2003). Fatigue models for applied research in warfighting. Supplement to *Aviation, Space and Environmental Medicine*, in review.

[3] Hursh SR (1998). *Modeling Sleep and Performance within the Integrated Unit Simulation System (IUSS).* Technical Report Natick/TR-98/026L. Science and Technology Directorate, Natick Research, Development and Engineering Center, United States Army Soldier Systems Command, Natick, Massachusetts 01760-5020.

[4] Hursh SR, Redmond DP, Johnson ML, Thorne DR, Belenky G, Balkin TJ, Miller JC, Eddy DR, Storm WF (2003). The DOD Sleep, Activity, Fatigue and Task Effectiveness Model. *Proceedings of the 12th Conference on Behavior Representation in Modeling and Simulation (BRIMS 2003)*, 03-BRIMS-001, 14-15 May 2003, Mesa, Arizona.

This page intentionally left blank.

Distribution list

Document No.: DRDC Toronto TR 2007-028

LIST PART 1: Internal Distribution by Centre:

2	DRDC Library
50	Michel Paul
52	TOTAL LIST PART 1

LIST PART 2: External Distribution by DRDKIM

1	A3 Fighters, 1 Canadian Air Division
1	Div Surg, 1 Canadian Air Division
2	TOTAL LIST PART 2

54 TOTAL COPIES REQUIRED

This page intentionally left blank.

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) Defence R&D Canada – Toronto 1133 Sheppard Avenue West P.O. Box 2000 Toronto, Ontario M3M 3B9	2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.) UNCLASSIFIED

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

Cognitive Effectiveness of CF18 Instructor Pilots during Routine Training:

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Michel A. Paul; Gary W. Gray; James C. Miller

5. DATE OF PUBLICATION (Month and year of publication of document.) February 2007	6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) 34	6b. NO. OF REFS (Total cited in document.) 2

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Technical Report

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)
DRDC Toronto, 1133 Sheppard Ave. West, Toronto, M3M 3B9
Defence R&D Canada – Toronto
1133 Sheppard Avenue West
P.O. Box 2000
Toronto, Ontario M3M 3B9

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) BL 2 Tasking	9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)
10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.) DRDC Toronto TR 2007-028	10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)
Unlimited distribution
Unlimited

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))
Unlimited announcement

13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

Introduction. 410 Squadron (the operational training squadron -OTS- for CF18 pilots) was tasked to evaluate the efficacy of night vision goggles (NVG). Since evaluation of NVGs involves night flying operations along with the inevitable circadian stresses induced by night operations, and since exercise Wolf Safari (an around-the-clock air-to-ground bombing exercise) occurred at 4 Wing (the same base as 410 OTS) there was an opportunity to capitalize on exercise Wolf Safari by running a parallel evaluation on instructor pilots of 410 OTS during their evaluation of NVGs. **Methods:** Cognitive effectiveness was predicted using the Fatigue Avoidance and Scheduling Tool (**FAST^{TM}**). Based on sleep and wakefulness data, the program predicts cognitive effectiveness**. Results. The FAST^{TM}** analysis predicted moderate cognitive impairment in all three instructor pilots during stand-by duty and during flight. **Discussion.** The lowest predicted cognitive effectiveness levels (during duty periods of these pilots) was due to inadequate sleep the night prior the duty periods in question. The anticipated tasking for 410 OTS to assess NVGs did not take place. However, should such an NVG tasking materialize in the future, the FAST^{TM} tool would predict that the night flying inherent in such an evaluation could cause more deleterious effects on cognitive effectiveness. This report can serve as baseline against which the anticipated more severe effects on cognitive effectiveness (of a future NVG assessment) can be compared.

Introduction. Le 410^{e} Escadron (escadron d'entraînement opérationnel [EEO] pour les pilotes de CF18) a été chargé d'évaluer l'efficacité des lunettes de vision nocturne (LVN). Comme l'évaluation des LVN nécessite des vols de nuit accompagnés des inévitables variations du rythme circadien induites par les vols de nuit, et comme l'exercice World Safari (exercice de bombardement air-sol ininterrompu) avait lieu à la 4^{e} Escadre (où est basé le 410 EEO), il y avait une occasion de profiter de l'exercice World Safari en tenant une évaluation parallèle sur les pilotes instructeurs du 410 EEO lors de leur évaluation des LVN. **Méthodes :** L'efficacité cognitive a été prédite au moyen de l'outil de programmation et d'évitement de la fatigue (**FAST^{TM}**). Sur la foi des données de sommeil et de vigilance, le programme prédit l'efficacité cognitive. **Résultats.** L'analyse **FAST^{TM}** a prédit une déficience cognitive moyenne chez les trois pilotes instructeurs pendant la période de disponibilité et le vol. **Exposé.** Les niveaux d'efficacité cognitive les plus faibles prévus (pendant la période de service de ces pilotes) avaient été causée par un sommeil insuffisant la nuit précédant les périodes de service en question. La mission prévue pour le 410 EEO d'évaluer les LVN n'a pas eu lieu. Par contre, si cette mission sur les LVN devait être reprise ultérieurement, l'outil FAST^{TM} prédirait que le vol de nuit propre à cette évaluation pourrait avoir des effets nuisibles sur l'efficacité cognitive. Le présent rapport peut servir de référence pour comparer les effets plus graves anticipés sur l'efficacité cognitive (d'une évaluation ultérieure de LVN).

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

cognitive effectiveness; performance; fatigue;

Defence R&D Canada

Canada's Leader in Defence
and National Security
Science and Technology

R & D pour la défense Canada

Chef de file au Canada en matière
de science et de technologie pour
la défense et la sécurité nationale

DEFENCE DÉFENSE

www.drdc-rddc.gc.ca